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Soil Fertility and Management Experiments 1958

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SOIL FERTILITY AND MANAGEMENT EXPERIMENTS 1958

Agricultural Experiment Station
South Dakota State College
Brookings, South Dakota

SOIL FERTILITY AND MANAGEMENT EXPERIMENTS

1958

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The soil experiments reported in this summary were conducted on representative soil types in the major crop areas of the state.

The objectives of these experiments were:

1. To determine the effects of nitrogen, phosphorus and potash fertilizers, applied at various rates and combinations, on the yields of crops.
2. Compare the effect on yield of fall application of fertilizer to spring application.
3. Evaluate methods of application on the yield of small grain.
4. Appraise the influence of soil types and previous management on fertilizer response.
5. Ascertain the residual effects of commercial fertilizer, especially nitrogen.
6. To compare legumes as a source of nitrogen to commercial fertilizer nitrogen.
7. To determine the effect of tillage, crop residues and fertilizer applied with residues on the yields of crops.
8. To study soil management systems for the improvement of crop yields on claypan soils.
9. Relation of legumes and subsoil moisture to corn yields.

The growing season in 1958 was characterized by a general deficiency of moisture. The June and July temperatures were below normal which was very favorable for the growth and development of the small grain crop. The August temperatures were about normal but the rainfall was below normal. The adverse weather in August imposed a low ceiling on corn yields in most areas.

Maintenance of the productive capacity of the soil requires the restoration of plant food through soil improvement practices which include the application of fertilizers, returning manure, crop residues, use of good rotations including a legume. Other soil management practices including proper tillage and soil moisture conservation and erosion control are also essential features of sound soil management. The experiments reported in this summary are concerned with these practices and serve as a guide for the development of sound soil management systems for the various crop and soil areas of the state.

The crop yields reported for the various experiments are for the year 1958 only and may not reflect the average response, which will be obtained over a period of years.

The assistance of the County Agents, Bureau of Indian Affairs, and Soil Conservation Service representatives in the counties where the outlying experiments were performed, is gratefully acknowledged.

MAIN EXPERIMENT STATION
BROOKINGS

Table 1. Effect of Nitrogen Fertilizer and Legumes on The Yields of Crops, Agronomy Farm 1958

Treatment	Yield in bushels per acre			
	Corn	Oats	Flax	Wheat
Corn-oats-flax-wheat-no fertilizer or legume	24.0	51.6	11.5	17.1
Corn-oats-flax-wheat + 20# N	16.5	53.1	11.4	19.7
Corn-oats-flax-wheat + 40# N	14.8	65.6	13.7	17.9
Corn-oats-flax-wheat + 60# N	14.3	72.9	13.6	18.8
Corn-oats-flax-red clover	5.9			
Corn-oats-flax-sweet clover	8.4	60.8	10.5	---
Corn-oats-flax-alfalfa	7.2			
L.S.D.	8.9	14.5	3.8	N.S.

Objective of experiment

1. To compare legumes as a source of nitrogen to nitrogen fertilizer.

Description of soil and location

Vienna loam in Brookings County. This is a well-drained upland soil derived from glacial till.

Discussion and interpretation of results

The rotation consisted of corn-oats-flax-wheat or legume. Previous to 1957, sweet clover was the only legume included in the rotation. Now the rotations are set up so that the comparative effect of red clover, sweet clover and alfalfa can be measured.

All of the plots received an application of 20 pounds of phosphoric acid per acre per year, except the check plots which had no application of fertilizer and had no legume.

The crop season at this location was characterized by a pronounced spring drought and August drought. The drought and high temperature in August had serious effects on corn yields.

Legumes and nitrogen fertilizer depressed the yields of corn. This depression was the result of the August drought. Oat yields were increased by fertilizer treatment. Flax and wheat yields were not significantly influenced by the application of fertilizer. The spring drought reduced the yield potential of both flax and wheat.

Table 2. Effect of Fertilizer Treatment on Crop Yields in a Rotation of Corn and Oats, Agronomy Farm, 1958

Treatment Pounds per acre N	P_2O_5	K_2O	Yield in bushels per acre Corn	Oats
0	0	0 (check)	25.8	45.9
20	0	0	17.8	49.1
0	20	0	24.6	44.5
0	0	30	27.3	44.1
20	0	30	18.4	42.8
20	20	0	17.2	64.1
0	20	30	21.6	48.2
20	20	30	11.3	54.7
L.S.D. at 5% level			5.7	12.3

Objective of experiment

1. The object of this experiment was to determine the effect of various fertilizers, applied alone or in combination on the yields of crops.

Description of soil and location

Vienna silt loam in Brookings County

Discussion and interpretation of results

A rotation of corn and small grain was used for the past 14 years. There was a pronounced increase in the yields of oats by the application of a combination of nitrogen and phosphorus fertilizer. Nitrogen applied alone without phosphorus was not effective for increasing the yield of oats. The inclusion of potassium with nitrogen and phosphorus tended to depress the yield of oats. The drought in August placed a low ceiling on corn yields. As the result of the drought the fertilizer treated corn plots yielded less than the check plots.

Table 3. Effect of Fertilizer, Crop Residues and Tillage on Crop Yields, Agronomy Farm, 1958

Treatment	Yield in bushels per acre		
	Corn	Oats	Wheat
Plowing, no residues returned	24.5	45.3	17.7
Plowing with residues returned	22.1	57.1	20.6
Subsurface no residues	38.4	47.4	20.9
Subsurface with residues	44.3	52.0	20.5
Subsurface with residues & manure	42.1	55.9	25.9
Subsurface with residues & nitrogen	40.9	58.7	24.8
Subsurface with residues & phosphorus	46.2	48.4	22.2
Subsurface with residues, nitrogen + phosphorus	43.4	58.4	26.4
L.S.D. at 5% level	10.3	8.1	4.7

Objective of experiment

1. The purpose of this experiment was to determine the effect of different tillage methods, crop residue, manure and fertilizer applied with residues on the yields of corn, oats and wheat.

Description of soil and location

Vienna loam in Brookings County

Discussion and interpretation of results

The rotation used was corn, oats and wheat for the past 15 years. Nitrogen was applied at the rate of 20 lbs. of N per acre, and phosphorus at 20 lbs. of P_2O_5 per acre. The yields of oats and wheat were increased by the application of nitrogen alone and by the application of nitrogen and phosphorus together. Ten tons of manure applied once in three years to the rotation also increased the yields of oats and wheat. The yields of corn were much higher where the seedbed was prepared by subsurface tillage.

Table 4. Effect of Clovers and Fertilizer on Crop Yields, Agronomy Farm, 1958

Treatment	Yield in bushels per acre		
	Corn	Wheat	Oats
Sweet clover - plowed June	41.4	28.6	---
Sweet clover - plowed June + Phosphorus	40.7	32.4	---
Sweet clover - plowed August	13.7	28.5	---
Sweet clover - plowed August + Phosphorus	11.2	30.5	---
Red clover + phosphorus	11.2	28.6	---
Corn-wheat-oats + sweet clover-catch crop + phosphorus	13.2	23.6	50.3
Corn-wheat-oats + 30#N + 20#P	18.9	29.4	45.5
Corn-wheat-oats No fertilizer or legume	23.5	24.1	53.1
L.S.D. at 5% level	6.7	4.2	N.S.

Objective of experiment

1. To compare the effects of sweet clover, red clover and fertilizer on the yields of crops.

Description of soil and location

Vienna silt loam in Brookings County

Discussion and interpretation of results

Where legumes occurred in a rotation, a sequence of clover-corn-wheat was used. There were two non-legume rotations, one with commercial fertilizer, one without. This allows a comparison of the effects of commercial fertilizer to the effects of a legume in a rotation.

The yields of wheat were significantly increased by clovers and nitrogen and phosphorus fertilizer. A catch crop of sweet clover was not effective for increasing the yield of wheat. The use of phosphorus with clover increased the yield of wheat more than sweet clover alone. The application of 30 lbs. of nitrogen each year to the corn-wheat-oats rotation increased the yield of wheat about as much as the yield increase from sweet clover.

The yields of corn were the highest where the sweet clover was plowed in June. The higher yields for this practice was due to the conservation of soil moisture by the earlier plowing. The depletion of soil moisture by red clover and sweet clover plowed in August caused a sharp decrease in corn yields.

All of the sweet clover crop was returned to the soil for green manure. The first crop of red clover was harvested for hay and the second crop was used for green manure.

The yields of oats were not significantly influenced in this experiment by fertilizer treatment.

Table 5. Effect of Different Types of Tillage Practices on the Yields of Crops, Agronomy Farm, 1958

Treatment	Yield in bushels per acre		
	Corn	Oats	Wheat
Subsurface	40.6	47.2	25.9
One-way	26.2	50.3	21.1
Double-disc	28.7	49.2	20.3
Plow 4"	19.3	58.9	22.5
Plow 7"	22.8	53.3	25.5
Plow 10"	19.5	60.6	23.8
L.S.D.	3.57	N.S.	4.2

Objective of experiment

1. The objective of this experiment was to determine the effect of seedbed preparation by different tillage methods on the yields of crops.

Description of soil and location

Vienna loam in Brookings County

Discussion and interpretation of results

The rotation used was corn, oats and wheat for the past 15 years. In order to supply adequate nutrients for the crop, nitrogen was applied at the rate of 30 lbs. N per acre and phosphorus at 20 lbs. of P_2O_5 per acre each year to all crops in the rotation.

Small grain yields were not markedly influenced by the various tillage practices. Corn yields were significantly influenced by tillage. The yield of corn produced with the subsurface tillage practice was approximately double the yield obtained where the seedbed was prepared by plowing. Corn yields were much reduced by the prolonged summer drought. The apparent effect of moisture conservation by the subsurface tillage practice had a very beneficial effect on corn yields.

CLAYPAN RESEARCH FARM
PLANKINTON

Table 6. Effects of Fertilizer, Legumes, Manure and Fallow on Yield of Crops on a Claypan Soil, Plankinton, 1958

Rotation	Yield in bushels per acre				
	Sorghum	W. Wheat	Corn	Oats	S. Wheat
1 WW-C-O-A	--	30.0	3.9	59.4	--
2 WW-C-O-F (Sw Cl)	--	40.9	11.0	55.9	--
3 WW-C-O-F	--	36.9	9.2	43.2	--
4 WW-C-O-W	--	22.4	9.4	49.3	17.7
5 WW-C-O-W (N)	--	29.5	2.6	59.7	23.2
6 WW-C-O-W (M)	--	30.9	5.4	58.7	22.0
7 WW-C-O-W (N + S)	--	30.3	8.4	57.5	26.8
8 A-C-O-A	--	--	6.6	53.6	--
9 O-C-O-W (G.M.)	--	--	10.2	54.6	26.8
10 O-C-sor-W (G.M.)	8.5	--		55.3	24.6
L.S.D. at 5% level		4.7	N.S.	8.3	4.8

WW = winter wheat
A = alfalfa
F (Sw Cl) = Sweet clover fallow
(M) = 20 T manure per rotation applied in alternate years

C = corn
O = oats
W = spring wheat
F = fallow

Sor = sorghum
(N) = 30# N/A/yr.
(N+S)= 30# N/A/yr. plus subsoiling in alternate years

G.M. = green manure catch crop of sweet clover planted with the small grain that precedes corn, and of alfalfa planted with the small grain that precedes spring wheat.

Objectives of experiment

1. To study soil management systems for the improvement of crop yields on claypan soils.

2. To measure the beneficial effects of fertilizer on crop yields.

3. To compare the effects of commercial fertilizer to manure or legumes on crop yields.

4. To determine whether fallow has a place in the soil management system.

Description of soil and location

A solonetz complex soil in Aurora county

Discussion and interpretation of results

The rotation experiment on the claypan soil has been in operation for 5 years. This allows the comparison of all the treatments in all the rotations.

Climatic conditions were very favorable during the early part of the growing season, therefore, small grain yields were generally good. The shortage of moisture during the latter part of the season, however, caused corn and sorghum yields to be low.

Where the soil fertility was maintained at a high level, the yield of winter wheat was markedly increased over that of a check rotation. Yields of winter wheat following fallow or sweet clover fallow were approximately 15 bushels per acre greater than in rotation 4, where no beneficial practices were used. One year of alfalfa, nitrogen or manure caused approximately the same increase in yield, roughly 8 bushels per acre. Subsoiling did not significantly affect the yield.

Wheat and oat yields were increased from the use of nitrogen, supplied either from legumes, manure or commercial fertilizer.

The different soil management systems had essentially no significant effect on corn or sorghum yields. The effect of the claypan in the soil was so dominant, that without ample moisture, a very low ceiling was placed on the yield of corn.

There appears to be some differences between treatments in corn yields but these are largely due to the nature and variable amount of claypan in the plot area. The yield of grain sorghum was similar to the yield of corn.

RANGE FIELD STATION

COTTONWOOD

Table 7. Effect of Commercial Fertilizer and Manure on Yields of Grain in a Forage Sorghum-Wheat-Barley Crop Sequence, Cottonwood, 1958

Treatment	Yield in bushels per acre	
	Barley	Wheat
Check	16.2	25.9
Manure	20.4	31.2
0-20- 0	14.7	24.3
20- 0- 0	25.3	30.0
40- 0- 0	41.4	30.5
20-40- 0	22.1	30.0
40-40- 0	33.9	39.0

Objective of experiment

1. To compare the effect of manure to commercial fertilizer on the yield of barley and wheat in a sorghum-wheat-barley rotation.

Description of soil and location

Pierre clay in west central South Dakota

Discussion and interpretation of results

The crop sequence followed was forage sorghum-wheat-barley. Commercial fertilizer was applied every year at the rates shown in the above table. Manure was applied at 6 tons per acre in the sorghum year only.

Both barley and wheat responded favorably to the use of nitrogen fertilizer. Phosphorus does not appear to be necessary. Since the experiment was started, phosphorus has never given a significant increase in yield. The effect of manure on the wheat yields compared favorably to that obtained from commercial nitrogen. Manure gave some increase in barley yields but not as much as with commercial fertilizer. The barley crop was the 3rd year removed from the manure treatment. Six tons of manure once in a 3-year sequence were not adequate to provide nutrients to the third crop following application of manure.

CENTRAL STATION

HIGHMORE

Table 8. Effect of Fertilizer on Yields of Grain in a Sorghum-Wheat-Oats Rotation, Highmore, 1958

Treatment Pounds per acre N	P_2O_5	K_2O	Yield in bushels per acre Wheat	Oats	Sorghum
0	0	0	34.0	55.8	20.0
0	40	0	36.0	56.1	17.4
20	40	0	37.5	68.4	22.9
40	40	0	35.8	74.1	23.5
L.S.D. at 5% level			N.S.	12.6	N.S.

Objective of experiment

1. To determine the influence of fertilizer treatments on the yields of sorghum, wheat and oats.

Description of soil and location

Williams loam in Hyde County

Discussion and interpretation of results

Crop yields were not influenced by the application of phosphorus fertilizer at Highmore this past year. Nitrogen caused a highly significant increase in yield of oats. Yields of wheat and sorghum were not significantly increased by use of nitrogen, although the data do show a trend in favor of nitrogen.

NORTHEAST STATION
WATERTOWN

Table 9. Comparison of Legume Nitrogen to Commercial Nitrogen for Increasing Spring Wheat Yields, Northeast Research Farm, 1958

Preceding Crop or treatment	Pounds per acre of fertilizer applied to wheat N	P_2O_5	K_2O	Spring wheat bu./A.	% protein in grain
1 Oats	0	20	0	28.7	11.20
2 Oats	30	20	0	33.2	12.37
3 Alfalfa for hay	0	20	0	33.3	15.57
4 Red clover for hay	0	20	0	36.2	14.03
5 Sweet clover for seed	0	20	0	42.5	14.48
6 Sweet clover fallow	0	20	0	37.9	15.28
L.S.D. at 5% confidence level				3.92	

Objective of experiment

1. Compare legume nitrogen to commercial nitrogen for increasing spring wheat yields.

Description of soil and location

Kranzburg silt loam in Codington County - approximately 2 to 2 1/2 feet of windlaid silts overlying glacial till.

Cropping history and past management

Very limited use of legumes and no commercial fertilizer prior to 1956. This experiment was started in 1956, and continued through 1957 and 1958.

Discussion and interpretation of results

Both commercial nitrogen and the inclusion of a legume in the rotation increased the yield of spring wheat.

The rotation with sweet clover for seed increased the yield of the following crop - wheat - more than rotations including alfalfa or red clover harvested for hay. It should be noted that in this experiment each of the legumes harvested for hay or seed were allowed to grow for 2 years - the seeding year and one full year for hay or seed. In the sweet clover fallow treatment, the sweet clover was allowed to grow until approximately 10 inches high the second year before plowing it under.

The sweet clover fallow treatment gave an increase in wheat yield but hardly enough to compensate for the year that no income was taken from the land. There was a substantial increase in protein content of grain, especially in some of the legume rotations.

Table 10. Residual Effect of Commercial Fertilizer on Yield of Corn and Percent Protein in Grain, Northeast Research Farm, 1958

1956 fertilizer treatment			Fertilizers applied in both 1957 and in 1958			1958 yield of corn	1958 % protein
N	P_2O_5	K_2O	N	P_2O_5	K_2O	bu./A.	in corn grain
0	0	0	0	0	0	43.3	10.29
40	20	0	40	20	0	46.2	10.88
80	40	0	0	0	0	46.5	10.57
120	60	0	0	0	0	44.2	10.56
160	80	0	0	0	0	48.0	10.78
200	100	0	0	0	0	46.4	10.63
L.S.D. at 5% confidence level						3.3	---

Objectives of experiment

1. When large quantities of fertilizer are applied, what will be the carry over effect on following crops?

2. Is it best to apply smaller quantities of fertilizer every year or large quantities once every 4 or 5 years?

Description of soil and location

Kranzburg silt loam in Codington County - approximately 2 to 2 1/2 feet of windlaid silts overlying glacial till.

Cropping history and past management

Very limited use of legumes and no commercial fertilizer prior to 1956.

Discussion and interpretation of results

This is the third crop taken from these plots (corn in 1956, oats in 1957, and corn in 1958). Residual or carry over effect on the third crop (corn) after fertilization amounted to an increase of about 3 or 4 bushels per acre.

SOUTHEAST STATION

MENNO

Table 11. Comparison of Catch Crop Legumes to Commercial Nitrogen for Increasing Yield of Corn and Percent Protein in Grain, Southeast Research Farm, 1958.

Preceding legume	Pounds per acre N	P_2O_5	K_2O	Corn yield bu./A.	% protein in corn grain*
1 None	0	20	0	44.9	10.88
2 None	40	20	0	44.7	12.04
3 Biennial sweet clover catch crop	0	0	0	47.0	11.32
4 Annual sweet clover catch crop	0	0	0	46.3	11.06
5 Red clover catch crop	0	0	0	41.7	11.31
6 Alfalfa catch crop	0	0	0	46.3	11.75
7 Red clover for hay	0	0	0	37.0	13.00
8 Alfalfa for hay	0	0	0	38.0	12.72
L.S.D. at 5% confidence level				14.3	---

* Analyzed by Experiment Station Biochemistry Department

Objective of experiment

1. Compare legumes to commercial nitrogen for increasing yield of the following corn crop.

Description of soil and location

In Hutchinson County - a well-drained soil developed from glacial till of Mankato age in the James River watershed.

Cropping history and past management

No commercial fertilizer or manure and very limited use of legumes.

Discussion and interpretation of results

The term catch crop legume is used when referring to the legumes planted with small grain and plowed under that same fall.

In this experiment, none of the treatments significantly increased the corn yield over treatment number 1. Number 1 serves as a check plot, because no legumes or commercial fertilizer were used.

On those plots where alfalfa and red clover were held over for one year for hay, the yield of the next crop, corn, appeared to be lower than that of the check plot but not significantly so.

The percent protein in corn grain was increased more in rotations using commercial nitrogen and legumes for hay than in the catch crop legume rotations.

Table 12. Comparative Influence of Manure, Legumes and Commercial Fertilizer on Yields of Corn, Southeast Research Farm, 1958

Treatment	Yield in bushels per acre
10 tons of manure per acre	47.4
60-40-0 from commercial fertilizer	52.7
Skip row planting with legumes planted between rows plus 0-40-0	31.5
Check (no legumes, manure or commercial fertilizer)	43.0
L.S.D. at 5% confidence level	11.8

Objectives of experiment

1. Investigate the possibility of wide row corn spacing with legumes planted between rows. This is an attempt to build up organic matter and yet grow continuous corn.

2. Compare the effect of manure, legumes and commercial fertilizer for growing continuous corn.

Description of soil and location

In Hutchinson County - a well-drained soil developed from glacial till of Mankato age in the James River watershed.

Cropping history and past management

No commercial fertilizer or manure and very limited use of legumes.

Discussion and interpretation of results

The skip row planting had 2 rows spaced 42 inches apart and the third row was skipped. Legumes were planted in this space of 84 inches. The next year the two rows of corn were planted where the 84 inch strip of legumes were plowed under. In this way corn was grown every year on fresh legume sod.

The plots receiving 60-40-0 from commercial fertilizer appeared to yield the best. The skip row corn with interplanting of legumes resulted in lower yields.

EXPERIMENTS ON PRIVATE FARMS

Table 13. Effect of Fertilizer on Yield of Oats, Bennett County, 1958

Treatment Pounds per acre			Soil Type	
N	P_2O_5	K_2O	Keith silty clay loam bu./A.	Keith silt loam bu./A.
0	0	0	48.8	20.9
0	0	40	42.5	21.9
0	40	0	46.7	24.0
40	0	0	65.3	30.3
20	40	0	58.0	24.5
40	20	0	59.8	28.3
40	40	0	66.3	30.7
40	60	0	58.7	28.0
60	40	0	63.9	37.1
40	40	40	62.9	23.9
L.S.D. at 5% level			6.1	7.6

Objective of experiment

1. To determine the effect of various combinations of nitrogen, phosphorus and potash on the yield of oats on some major soil types in Bennett County.

Description of soils

Keith silty clay loam--well-drained soil formed in deep loess on a 0 - 1% slope. Calcareous at 24 inches.

Keith silt loam--well-drained deep loess soil on a 3% slope. Calcareous at 24 inches.

Cropping history and past management

Both soils have been cropped to either small grains or corn with limited use of soil improving practices. Both sites were planted to corn in 1957.

Discussion and interpretation of results

Additional nitrogen was necessary to increase crop yields. Phosphorus or potash did not cause significant increases in yield.

Table 14. Effect of Fertilizer on Yield of Oats in bushels per acre, Eastern South Dakota, 1958

Rates of Fertilizer	Brookings Co. site 1	Clay Co. site 2	Codington Co. A site 3	Codington Co. B site 4	Grant Co. site 5	Lincoln Co. A site 6	Lincoln Co. B site 7	Minnehaha Co. site 8
0- 0- 0	25.5	51.3	66.5	43.3	34.4	48.8	42.0	31.4
20- 0- 0	23.1	49.1	63.8	43.1	44.9	46.9	41.3	38.3
40- 0- 0	24.4	49.1	62.2	42.9	54.0	49.4	42.9	42.9
20-30- 0	32.9	52.8	77.3	47.0	51.9	61.3	46.8	41.0
40-30- 0	38.6	56.8	77.7	49.1	55.9	60.5	44.7	47.7
L.S.D. at 5% level	9.5	N.S.	8.4	N.S.	11.1	10.1	N.S.	7.1

Objective of experiment

1. To determine the effect of the various combinations of nitrogen and phosphorus on the yield of oats on some major soil types in eastern South Dakota.

Description of soils

1. Sites 1 and 3 were Vienna loam, a well-drained upland soil developed from glacial till.

2. Sites 2 and 6 were Trent silt loam, a moderately well-drained upland soil developed from windlaid silts overlying glacial till.

3. Sites 4 and 7 were Kranzburg silt loam, a well-drained upland soil developed from windlaid silts overlying glacial till.

4. Site 5 was Barnes loam, a well-drained upland soil developed from glacial till.

5. Site 7 was Moody silt loam, a well-drained upland soil derived from windlaid silts over glacial till.

Cropping history and past management

All locations were continuously cropped to a corn-oats rotation with limited use of fertility improving practices.

Discussion and interpretation of results

There was no response to fertilizer at sites 2, 4 and 7, due mainly to drought in these areas. Drought also limited the response to fertilizer at sites 1, 3 and 6, but these soils showed a significant increase in yield due to phosphorus. These three sites were low in phosphorus, according to soil test. Sites 5 and 8 were low in phosphorus and there was a significant response to both nitrogen and phosphorus.

Table 15. Effect of Fertilizer on Yield of Oats.

Treatment	Kingsbury Co. bu./A.	Brookings Co. bu./A.
0-0-0	39.9	36.4
20-0-0	65.4	47.7
0-20-0	40.3	35.9
20-20-0	70.5	--
40-20-0	99.6	59.7
20-40-0	71.9	52.9
40-40-0	100.9	64.8
40-40-40	91.2	--
80-40-0	--	74.0
160-40-0	--	82.8
40-80-0	--	73.0
40-160-0	--	78.4

Objective of experiment

1. Determine the effect of rates of application of nitrogen and phosphorus on the yield of oats on representative soils of eastern South Dakota.

Description of soil and location

Kingsbury Co. - Poinsett Silty Clay Loam - a well-drained upland soil developed in glacial till. Gently rolling topography.

Brookings Co. - Kranzburg Silt Loam - a well-drained upland soil developed from windlaid silts overlying glacial till.

Past management and cropping history

Kingsbury Co. - This site has been utilized in a corn - small grain rotation with no known history of soil building practices or fertilizer use.

Brookings Co. - This Brookings Co. site has a history of corn - small grain rotation with commercial fertilizer applied to the corn at the rate of 10 pounds of nitrogen and 20 pounds of phosphorus per acre in 1955 and 1957. No history of legumes or other soil building practices known.

Discussion and interpretation of results

On the Poinsett location in Kingsbury Co. excellent results from fertilizer application was obtained with all treatments producing highly economical yield increases except the treatment involving the application of phosphorus alone.

On the Kranzburg site in Brookings Co. all treatments resulted in yield increase with all treatments being economical with the exception of heavy (160#) nitrogen treatment.

Table 16. Effect of Fertilizer on Yield of Barley in Bennett County, 1958

Treatment Pounds per acre			Soil Type	
			Rosebud	Keith
N	P_2O_5	K_2O	silt loam bu./A.	silt loam bu./A.
0	0	0	22.9	21.1
0	0	40	20.7	20.0
0	40	0	21.5	21.6
40	0	0	37.5	33.5
20	40	0	30.7	30.6
40	20	0	36.6	31.6
40	40	0	34.7	38.5
40	60	0	36.4	34.4
60	40	0	37.9	37.3
40	40	40	35.9	32.6
L.S.D. at 5% level			7.2	5.5

Objective of experiment

1. To determine the effect of various rates and combinations of nitrogen, phosphorus and potash on the yield of small grains on representative soil types.

Description of soils

Rosebud silt loam - a well-drained zonal soil developed from calcareous semi-consolidated siltstone strata on a 2% slope.

Keith silt loam - well-drained deep loess soil on a 0 - 1% slope. Calcareous at 24 inches.

Cropping history and past management

Both soils have been cropped to either small grain or corn with limited use of soil improving practices.

Discussion and interpretation of results

Nitrogen was the limiting element as far as obtaining top yield was concerned. As much as 75% increase in yield over the check was obtained when the higher rates of nitrogen were used on both soils. Phosphorus or potassium fertilizers were not needed on either soil.

Table 17. Effect of Fertilizer on Yield of Barley in bushels per acre in Eastern South Dakota, 1958

Rates of Fertilizer	Brookings Co. site 1	Brookings Co. site 2	Clay Co. site 3	Deuel Co. site 4
0-0-0	54.5	26.9	41.3	29.9
20-0-0	50.2	31.1	39.5	35.2
40-0-0	52.1	32.4	47.4	34.5
20-30-0	51.0	43.7	45.2	44.1
40-30-0	53.9	41.5	47.0	45.4
L.S.D. at 5% level	N.S.	11.1	N.S.	8.5

Objective of experiment

1. To determine the effect of the various combinations of nitrogen and phosphorus on the yield of barley in eastern South Dakota.

Description of soils

1. Sites 1 and 4 were Kranzburg silt loam, a well-drained upland soil developed from windlaid silts overlying glacial till.

2. Site 2 was Vienna loam, a well-drained upland soil developed from glacial till.

3. Site 3 was Trent silt loam, a moderately well-drained upland soil developed from windlaid silts overlying glacial till.

Cropping history and past management

1. Site number 1 was in alfalfa in 1954, flax in 1955 and 1956 and corn in 1957.

2. Sites 2 and 3 were continuously cropped to a corn - small grain rotation with limited use of fertility improving practices.

3. Site number 4 was largely continuous small grain with the use of no manure, fertilizer or legume.

Discussion and interpretation of results

There was no significant response to fertilizer at sites 1 and 3. At site number 1 there was adequate rainfall and favorable temperatures. There may have been a residual effect to the alfalfa 3 years before. Soil tests showed available phosphorus was very high. At site number 3 drought limited any response to fertilizer.

At sites 2 and 4, the soil tests indicated a low available phosphorus content, and the yields showed a significant increase due to phosphorus and nitrogen together, but not nitrogen alone. Drought somewhat limited the yields at site number 2.

Table 18. Residual Fertilizer Effect on Small Grain

Treatment	Barley Brookings Co. bu./A.	Oats Deuel Co. bu./A.
0- 0- 0	49.5	42.0
20- 0- 0	51.3	--
0-20- 0	55.1	--
20-40- 0	57.2	--
40-40- 0	55.5	--
80-40- 0	63.3	81.5
160-40- 0	65.1	--
40-20- 0	55.1	--
40-80- 0	64.5	60.8
40-160-0	65.8	--
80-80- 0	--	72.7
120-80- 0	--	86.2
80- 0- 0	--	64.1
120-80-80	--	91.3

Objective of experiment

To determine the residual or carry over effect of fertilizer applied to corn in 1957 on the small grain crop in 1958. No fertilizer was applied to the small grain plots in 1958.

Description of soil and location

Brookings Co. - Kranzburg silt loam - well-drained upland soil developed from windlaid silts overlying glacial till. Gently undulating topography.

Deuel Co. - Flandreau - well-drained upland soil developed in loam or silt loam loess overlying wind blown sands, on gently rolling topography.

Past management and cropping history

Brookings Co. - The cropping history of this site is alfalfa in 1952 and 1953, corn in 1954, corn in 1955, flax in 1956, and corn in 1957. Phosphorus fertilizer at the rate of 65 lbs. per acre of P_2O_5 was applied in 1952 with no subsequent application other than the experimental application in 1957.

Deuel Co. - This site has been in a corn small grain rotation with no history of commercial fertilizer application or soil improvement practices. Application of barnyard manure has been made at irregular intervals with incomplete coverage. This land was recently reclaimed from a heavy quack grass infestation.

Discussion and interpretation of results

On the Kranzburg location in Brookings Co. a response to residual fertilizer was noted but proved to be uneconomical in most cases due to high residual fertility as a result of past management. Phosphorus appeared to be the most effective for increasing yields of barley.

On the Flandreau site in Deuel Co. highly economical yield increases due to the residual effect of fertilizer was noted. All treatments gave a substantial return per acre over the original cost of the fertilizer.

Table 19. Effect of Fertilizer on the Yield of Durum Wheat, Bennett County, 1958

Treatment Pounds per acre N	P_2O_5	K_2O	Yield in bushels per acre
0	0	0	6.7
0	0	40	6.7
0	40	0	7.3
40	0	0	12.8
20	40	0	12.3
40	20	0	11.6
40	40	0	10.7
40	60	0	12.1
60	40	0	15.8
40	40	40	14.7
L.S.D. at 5% level			4.0

Objective of experiment

1. To determine the effect of various rates and combinations of nitrogen, phosphorus and potash on the yield of wheat.

Description of soil

Anselmo fine sandy loam - soil formed in wind derived sandy sediments on a 1 1/2% slope.

Cropping history and past management

This soil has been cropped to small grain and row crops with limited use of soil improving practices.

Discussion and interpretation of results

The over-all yield of the experiment was somewhat low because of a relatively thin stand. Nevertheless, nitrogen caused as much as 100% increase in yield over the check when used at the higher rates. The data also show that the use of phosphorus and potash did not significantly increase the yield of durum wheat over the check plot.

Table 20. Effect of Time and Method of Placement, Source, and Rate of Fertilizer Application on Oats, Sanborn County, 1958

Treatment Pounds per acre N	P_2O_5	K_2O	Nitrogen source*	Placement** Method	Time	Yield in bu./A.
0	0	0	-----	--	---	20.2
20	0	0	solid	P	Fall	35.4
20	0	0	solution	P	Fall	29.4
40	0	0	solid	S	Fall	43.7
40	0	0	solid	S	Spring	47.9
40	0	0	solution	S	Spring	43.0
40	0	0	solid	P	Fall	42.7
40	0	0	solution	P	Fall	40.0
40	40	0	solution	P	Fall	44.7
40	40	0	solid	P	Fall	43.5
60	0	0	solid	P	Fall	44.8
60	0	0	solution	P	Fall	47.0
L.S.D. at 5% level						7.94

*Solid nitrogen fertilizer applied as NH_4NO_3
Solution nitrogen fertilizer applied as Uran 30
** P = Broadcast and plowed down
S = Broadcast on surface after plowing

Objectives of experiment

1. Compare a non-pressure liquid source of nitrogen fertilizer with a solid form.
2. Compare several methods of fertilizer placement
3. Compare effects of several rates and ratios of fertilizer application on yield of oats.

Description of soil and location

A moderately well-drained loam soil developed from glacial till and occurring on nearly level positions in Sanborn County.

Cropping history and past management

This location has been cropped to corn and small grain for several years and has received no fertilizer since 1953. At that time, nitrogen, in the form of anhydrous ammonia, was applied at the rate of approximately 100 lbs. per acre. Corn was grown on the plot site in 1957.

Discussion and interpretation of results

The only significant influence on oat yields was due to fertilizer application. Little or no effect on yield was noted from the different sources, methods, or times of fertilizer application.

Table 21. Effect of Time and Method of Placement, Source, and Rate of Fertilizer Applications on Corn and Spring Wheat, Spink County, 1958

Treatment Pounds per acre N	P_2O_5	K_2O	Nitrogen source*	Placement** Method	Time	Corn bu./A. (1)	Spring wheat bu./A. (2)
0	0	0	----	-	---	87.0	17.8
20	0	0	solid	P	Fall	76.2	21.3
20	0	0	solution	P	Fall	61.5	22.1
40	0	0	solid	S	Fall	74.2	20.8
40	0	0	solid	S	Spring	72.9	20.5
40	0	0	solution	S	Spring	81.3	21.1
40	0	0	solid	P	Fall	86.8	21.5
40	0	0	solution	P	Fall	68.9	21.2
40	0	0	solid	D	Fall	76.6	24.0
40	40	0	solid	P	Fall	69.4	25.0
40	40	0	solution	P	Fall	93.3	23.7
60	0	0	solid	P	Fall	75.5	22.1
L.S.D. at 5% level						N.S.	3.41

* Solid nitrogen fertilizer applied as NH_4NO_3
Solution nitrogen fertilizer applied as Uran 30

** P = Broadcast and plowed down
S = Broadcast on surface after plowing
D = Placed in bands approximately 2 feet apart and 16 inches deep

Objectives of experiment

1. Compare a non-pressure liquid source of nitrogen fertilizer with a solid form.
2. Compare several methods of fertilizer placement.
3. Compare effects of several rates and ratios of fertilizer application on grain yield.

Description of soil and location

Location 1 and 2

Hecla sandy loam - a moderately well-drained sandy loam occurring on nearly level positions in the sandy plain of Spink County. The parent material of this soil is fine sandy loam outwash that has been reworked by wind.

Cropping history and past management

Both locations have been continuously cropped to corn and small grains for over 15 years. The soils have never been fertilized previous to these experiments. The 1957 crop was spring wheat at both locations.

Discussion and interpretation of results

Corn yields were not significantly influenced by any of the various treatments. This may have been due to the differences in stand which resulted from unfavorable growing conditions early in the season. Spring wheat yields were significantly affected by fertilizer application, with no appreciable effect due to depth, time of placement or source of nitrogen.

Table 22. Effect of Rate and Placement of Fertilizer on Small Grain, Spink County, 1958

Treatment Pounds per acre N	P_2O_5	K_2O	Method of nitrogen placement*	Yield in bushels per acre Oats (1)	Spring wheat (2)
0	80	0	Check	31.1	30.4
0	80	0	Deep check (chiseled)	28.8	23.0
20	80	0	Broadcast	46.1	35.8
40	80	0	Broadcast	65.1	41.5
60	80	0	Broadcast	72.7	43.9
40	80	0	Deep	53.4	35.5
60	80	0	Deep	64.3	43.3
60	80	0	2/3 applied deep, 1/3 was broadcast	66.0	41.5
L.S.D. at 5% level				17.06	7.72

* NH_4NO_3 was applied in bands two feet apart and 18 inches deep on plots where nitrogen was deep-placed. Nitrogen was broadcast and disced in on other plots receiving nitrogen fertilizer. Phosphorus was broadcast on surface.

Objectives of experiments

1. Compare the effects on small grain yields of deep-placed nitrogen fertilizer with nitrogen broadcast on the surface.
2. Compare yield results from different rates of nitrogen fertilizer application.

Description of soil and location

Location 1

Hecla sandy loam - a moderately well drained sandy loam soil occurring on nearly level positions in the sandy plain of Spink County. The parent material of this soil is fine sandy loam outwash that has been reworked by wind.

Location 2

Harmony silty clay loam - a moderately well-drained soil having a slight claypan. This soil occurs on level positions on the glacial Lake Dakota Plain in Spink County. The parent material is lake-laid silts and clays.

Cropping history and past management

The cropping history for both sites has been corn and small grain for several years with no applications of fertilizer.

Discussion and interpretation of results

Yield increases due to fertilizer application were highly significant at both locations. These increases were apparently due to the rate of nitrogen fertilizer application rather than depth of placement.

Table 23. Effect of Nitrogen Fertilizer on Yield of Spring Wheat, Spink County, 1958

Treatment Pounds per acre N	P_2O_5	K_2O	Yield in bushels per acre
0	100	0	27.3
20	100	0	29.5
40	100	0	31.3
60	100	0	34.4
120	100	0	35.6
240	100	0	32.5
L.S.D. at 5% level			5.03

Objective of experiment

1. To determine the effect of various rates of nitrogen fertilizer application on yield of spring wheat.

Description of soil and location

Hecla sandy loam - a moderately well drained sandy loam soil occurring on nearly level positions in the sandy plain of Spink County. The parent material of this soil is fine sandy loam outwash that has been reworked by wind.

Cropping history and past management

The above location has been continuously cropped to corn and small grain for over 20 years, and has received no fertilizer in that time prior to this experiment.

Discussion and interpretation of results

Significant increases in wheat yields were not obtained until rates of over 40 lbs. per acre of actual nitrogen were applied.

Table 24. Response of Alfalfa to the Application of Major and Minor Elements in Grant County

Treat.	Rate/Acre	Yield in Lbs. Per Acre 1st Cut.	2nd Cut.	Total of 2 Cut.	Diff. due to Treatment
Check	0-0-0	1739	1960	3699	---
1	0-60-0 (135# 0-46-0)	3077	2275	5352	+1653 lbs.
2	0-60-0 (300# 0-20-0)	2814	2662	5476	+1777 "
3	0-0-40 (80# 0-0-60)	1756	1912	3668	- 31 "
4	0-60-40 (135# 0-46-0) (80# 0-0-60)	2911	2041	4952	+1253 "
5	Sulfur 30#	1967	1758	3725	+ 26 "
6	Boron 1 ppm	1822	2073	3895	+ 196 lbs.
7	40-0-0 (120# 33.5-0-0)	2230	1909	4139	+ 440 "
8	Molybdenum 1 ppm on soil	1717	1686	3403	- 296 "
8A	" 0.5 ppm on leaves	1563	1710	3273	- 426 "
9	Magnesium 50#	1559	1831	3390	- 309 "
10	9 minor elements* on soil	1607	1783	3390	- 309 "
10A	9 minor elements* on leaves	1067	1646	2713	- 986 "

Objective of experiment

1. Determine the effect of application of nitrogen, phosphorus, potassium, and various other major and minor nutrient elements on the growth of alfalfa on a representative soil of Northeastern South Dakota.

Description of soil and location

Barnes loam - a well-drained, friable upland soil developed in glacial till on gently undulating slightly rolling topography.

Past management and cropping history

This field of irregular size and shape has been devoted primarily to the production of grass and alfalfa. The present crop is a three year old stand of alfalfa which was fertilized in 1957 with 45 lbs. of P_2O_5 per acre applied as 0-62-0.

Discussion and interpretation of results

Two cuttings of alfalfa were harvested with only the phosphorus giving economical yield responses. Nitrogen gave positive results on the first cutting but was negative for the 2nd cutting. Potassium application resulted in a slight depression of yield as did most of the minor elements applied.

*Iron, Manganese, Magnesium, Copper, Cobalt, Zinc, Iodine, Sulfur, Boron.

Table 25. Effect of Fertilizer and Rates of Application on Yield and Percent Phosphorus in Alfalfa Hay in Southeastern South Dakota, 1958

Treatment Pounds per acre N	P_2O_5	K_2O	McCook County Yield total 1st & 2nd cutting lbs. per acre	% phosphorus in hay 2nd cutting
0	0	0	4451	.175
0	40	0	4699	.187
0	80	0	4736	.189
0	160	0	4621	.207
0	0	40	4520	.167
0	80	40	4848	.198
L.S.D. at 5% level			N.S.	-

Treatment Pounds per acre N	P_2O_5	K_2O	Lincoln County Yield of 1st cutting lbs. per acre	% phosphorus in hay 1st cutting
0	0	0	2782	.134
0	40	0	2867	.131
0	80	0	3473	.142
0	160	0	3685	.152
0	0	40	2430	.108
0	80	40	3239	.149
L.S.D. at 5% level			468	-

Treatment Pounds per acre N	P_2O_5	K_2O	Union County Yield total 4 cuttings lbs. per acre	% phosphorus in hay 3rd cutting
0	0	0	8310	.177
0	40	0	9207	.210
0	80	0	9393	.235
0	160	0	9874	.256
0	0	40	8506	.188
0	80	40	9655	.235
L.S.D. at 5% level			812	-

Objective of experiment

1. Determine effect of rates of phosphate and potash on alfalfa yields and phosphorus content of the plant material.

Description of soils and location

McCook County - Bonilla loam, a moderately well-drained upland soil developed in glacial till of Mankato age.

Lincoln County - Trent silt loam, a moderately well-drained soil developed from windlaid silts which overlie glacial till.

Union County - Crofton silt loam, a somewhat excessively drained soil derived from calcareous loess on 8-10% slope.

Cropping history and past management

No fertilizer had been applied prior to these experiments. The McCook County location was first year alfalfa; the Lincoln and Union County locations were second year alfalfa.

Discussion and interpretation of results

At the McCook County location, there appeared to be a slight increase in alfalfa yields due to fertilizer, but none were significant at the 5% confidence level.

At the Lincoln County location, a significant response in yield was obtained at the 80 and 160 pound P_2O_5 application rates. Potash, where used alone or in combination with phosphate, did not increase the yield of hay.

At the Union County site, good yield responses were obtained from fertilizer, especially from phosphorus. Potash, when applied alone, did not appreciably increase the yield of alfalfa.

In general, the percent of phosphorus in the hay increased with the increased rate of phosphorus fertilizer application.

Table 26. Effect of Fertilizer and Rates of Application on Yield and Percent Phosphorus in Alfalfa Hay in Northeastern South Dakota, 1958

Pounds per acre N	P_2O_5	K_2O	Deuel County Yield total 1st & 2nd cutting lbs. per acre	% phosphorus in hay 2nd cutting
0	0	0	1690	.180
0	40	0	2239	.226
0	80	0	2451	.235
0	160	0	2834	.275
0	0	40	1500	.184
0	80	40	2770	.228
L.S.D. at 5% level			398	

Pounds per acre N	P_2O_5	K_2O	Clark County Yield total 1st & 2nd cutting lbs. per acre	% phosphorus in hay 2nd cutting
0	0	0	4469	.147
0	40	0	5389	.157
0	80	0	5579	.158
0	160	0	5210	.188
0	0	40	3791	.136
0	80	40	5703	.175
L.S.D. at 5% level			746	

Objective of experiment

1. To determine the effect of rates of phosphate and potash on alfalfa yields and phosphorus content of the plant material.

Description of soils and location

Deuel County - a moderately well-drained loam derived from glacial till on level topography.

Clark County - Poinsett silt loam, well-drained upland soil developed from silty glacial drift.

Cropping history

No fertilizer had been applied prior to these experiments. Both locations were first year alfalfa.

Discussion and interpretation of results

Phosphorus gave an increase in alfalfa yield at both locations. Potash when applied alone gave no increase in yield of hay.

The phosphorus content in the second cutting of hay reported in these two experiments increased as the rate of phosphorus application was increased. This was especially true in the Deuel County experiment.